Indiana Department of Transportation

Land & Aerial Survey Office (LASO)

Photogrammetric Mapping Specifications and Services Manual

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Photogrammetric Mapping Services & Specifications Manual

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1. Mission Statement

"INDOT will plan, build, maintain, and operate a superior transportation system enhancing safety, mobility and economic growth[1]."

The Photogrammetry Section of the Land & Aerial Survey Office (LASO), part of the Capital Program Management Division within the Indiana Department of Transportation, is responsible for providing Design Scale Digital Mapping and associated products in a timely, cost efficient, and professional manner.

2. Purpose of Manual

The ***Photogrammetric Mapping Services and Specifications Manual*** defines standards and procedures for preparing, collecting, delivering, and archiving electronic photogrammetric mapping data and imagery that is created for the Indiana Department of Transportation (INDOT). To ensure the desired accuracy and integrity of all data, these standards shall be used in the preparation and delivery of all electronic deliverables defined within. These specifications shall apply to projects delivered by INDOT staff and consulting firms, unless otherwise approved by the Land & Aerial Survey Office (LASO).

The purpose of these standards and procedures is to obtain an optimal degree of statewide uniformity within the INDOT Aerial/Ground Combination Survey process, to establish and maintain Photogrammetric Standards for INDOT and contracted consultants, and allow for all of the project data to be effectively managed from conception to completion.

The effective date of the policies and procedures within this manual is February 9, 2011. This manual shall be updated on a continuing basis, with revisions issued periodically. The revision date shall be shown on the cover page of this document. The most current version shall be available electronically on the INDOT Land & Aerial Survey Office web site (www.LASO.indot.in.gov) and shall supersede any printed version(s). Some modifications to this manual are the direct result of changes in specifications, Department organization, and other requirements or as a result of recent experiences and technological advances. Other improvements or proposed revisions may be suggested by users. Suggestions to improve or revise the manual or reports of errors or omissions should be transmitted to the Land & Aerial Survey Office.

A legal standard for Aerial/Ground Combination surveys is not established or intended by this manual.

[1] http://www.in.gov/indot/

3. Contacts

For more information, to discuss your specific needs or to request Land & Aerial Survey services please feel free to contact us:

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4. Services

4.1 Preliminary/Planning Photography - This type of photography is often referred to as "Small Scale", which indicates that the ground features in this type of photography **a**re at a smaller, less detailed size. 1"=1000' is the most commonly used photo scale for this type of aerial photography. This imaging is generally used to provide an overview of a proposed project area to aid in planning.

4.2 Design Scale Photography - This type of photography is often referred to as "Large Scale", which indicates that the ground features in this type of photography are at a larger, more detailed size. 1"=200' is the only acceptable photo scale for this type of aerial photography. This imaging is used primarily to produce design grade mapping products.

4.3 Oblique Photography - These are side-on, angled photos that are captured at low altitude with our High Resolution hand held Digital Camera. These photos are most commonly used for scenic, panoramic or construction progress views. These images provide an increase coverage area within one photograph, however they are not used for making accurate quantitative measurements.

All of the photography scales and styles are used for general views of an area, planning/preliminary design, public hearings, legal court cases, hydrology studies, material borrow pit quantities, environmental issues and construction progress. The only Scale that is acceptable for stereo compilation is the Design Scale Photography.

4.4 Digital Imaging - This is the process in which the developed aerial film is used to produce digital image files. These files are created with the use of a photogrammetric scanner that meets all geometric and radiometric requirements.

4.5 Aerial Triangulation - Aerial triangulation is a mathematical process used to determine the easting, northing and vertical coordinates of an infinite number of points. The primary function of this process is to extend and densify the provided ground control in the aerial photo pairs. This process greatly reduces the number of points that shall be located during the ground survey and provides a means of verifying survey and stereo compilation accuracy, thus reducing project costs across the board.

4.6 Digital Stereo Compilation - This is the process that recreates the internal geometry of the aerial camera to produce a three-dimensional (3D) model of the terrain that is viewed on a high resolution computer monitor. The digital stereo compilation workstations support the real-time graphics to allow the CAD features to be viewed graphically overlaid in the 3D environment. After proper orientation, a digital terrain model (DTM) and topographic maps (contours) can be produced.

4.7 Digital Terrain Models - This is a digital representation of the ground surface topography or terrain in a pre-defined area. These terrain models are created by digitizing specific terrain features that depict the changes in the earth's surface. These terrain models

are often used in the production of topographic contour maps, to determine earthwork quantities, or to produce orthorectification photography.

4.8 Cartographic Editing - This is the process in which the photogrammetry staff will perform the final QA/QC for all of the stereo compilation data. During this process all of the Supplemental Ground Survey data shall also be added and checked for horizontal and vertical accuracies in relation to the three-dimension terrain view. In addition to checking the geographic accuracies the photogrammetry staff shall also review the data to check for missing data, digitizing correctness and for proper symbology placement.

5. Aerial\Ground Combination Survey Process

Aerial Photogrammetry can be defined as the science of compiling accurate measurements in aerial photographs to locate features on or above the surface of the earth. The end result produces the easting, northing and vertical coordinate position of a particular point, a planimetric feature, or a graphic representation of the earth's terrain.

Once a project is selected for Aerial Mapping services the photogrammetry staff will obtain the project limits to start the aerial flight planning process. From there the photogrammetry staff shall select the appropriate locations for the aerial ground control points based on the aerial flight lines and shall forward that information to the Land Surveyor in charge of the project. Once the field survey crew has physically placed the aerial ground control points, the aerial flight crew will be alerted and will be sent to acquire the aerial photography as soon as weather conditions are favorable. After the aerial photography acquisition mission is complete the photogrammetry section will have the film developed by a contracted consultant or an outside vendor. Once the film has been developed and returned, the Aerial Specialist will digitally scan the film and complete a QA\QC check on the film to make sure that the imagery meets the INDOT required specification. After the film has been scanned to produce digital image files, it is the responsibility of the Certified Photogrammetrist to complete all necessary Aerial Triangulation. Once the Aerial Triangulation results have been verified to meet or exceed INDOT required specifications, it shall be the responsibility of the Aerial Compilation staff to obtain the existing terrain data and convert it into useful CAD information for various INDOT programs. During the aerial compilation process, it shall be the responsibility of the photogrammetry staff to alert the Land Surveyor in charge of any items or areas that cannot be collected from the aerial photography. After the aerial compilation and the supplement ground survey has been completed, all CAD data shall need to be merged into one deliverable Bentley InRoads workspace. At the completion of merging all of the terrain data, the photogrammetry section shall produce orthorectified imagery that encompasses the project area.

6. Aerial Photogrammetry Advantages vs. Disadvantages

The technological era has pushed the Photogrammetry industry into a position where the advances have increased the details that can be collected, but at the same time this process is still a limited substitution for ground surveying. The photogrammetry process can relieve survey crews of time consuming tasks required to produce topographic maps and Digital Terrain Models (DTMs), but the ground survey methods will always remain an "essential and irreplaceable" part of the photogrammetric process. Increased amounts of information that pertain to a specific terrain area allow designers to investigate alternative alignments without having to collect additional field information. Surveys collected with the Aerial\Ground Survey Combination principle have both advantages and disadvantages in comparison.

Advantages

- As a general rule of thumb, projects that are 2 miles long (350 acres in total area) or larger will see a substantial cost savings by using Aerial Photogrammetric procedures to collect all needed Digital Terrain Models, Topographic Mapping and Orthorectified Imagery, compared to traditional ground survey methods.
- Aerial Photography provides a permanent "hard copy" record of the conditions as they where during the acquisition of the imagery.
- Aerial Photography can be supplied as an information resource that is available to the general public, federal and state agencies, and other INDOT programs.
- Reduction in amount of traffic disruptions necessary when ground survey crew must collect data in traffic zones.
- Provides a safer alternative to field survey crews collecting data in high volume traffic zones.
- Small scale Aerial Photography and Mosaics also provide an expansive overview for a projected area, and aids in the identification of project sensitive features. Aerial Photography can be utilized in locations that are complex or impractical to access from the ground.
- Extension of the DTM limits and additional planime**t**ric features can be extracted from the aerial photography with relatively little effort and cost.

Disadvantages

- Due to seasonal conditions, the acquisition process of the aerial photography could be delayed affecting the overall delivery schedule.

Given that the aerial photography is collected from above the planimetric features, it presents the issue that some data collection could be challenging due to dense vegetation, dark shadows, overhangs and water.

7. Specifications

Objective of Specifications

The objective of the Photogrammetry Specifications is to obtain an optimum degree of statewide uniformity in Aerial\Ground Combination Surveys procedures and to establish and maintain Photogrammetric standards. These specifications are to be used to define the performance and completion of work that is requested of the INDOT photogrammetry staff and all INDOT Photogrammetry Consultants.

7.1 Aerial Photography

7.1.1 General - As stated in the objective, the goal of these specifications is to obtain state wide uniformity. Effective immediately as a standard operating procedure, **All INDOT** projects that have an **Aerial Photography** or **Aerial/Ground Combination Survey** component are to be submitted to the Land & Aerial Survey Office (LASO) Photogrammetry Section for services. Once the requested products for any given project have been indentified, the Photogrammetry Section shall make the determinations if needed, to allocate any or all project needs to available contracted consultants.

7.1.2 Aircraft - All consultants performing Aerial Photography Acquisition Missions shall utilize an aircraft capable of flying at the required operational altitude and ground speed to insure the accuracy standards as dictated by the project specifications. It shall also be required that the flight crews keep an accurate flight log to the nearest tenth (0.1) of an hour between takeoff and landing. This flight log will need to be signed by the pilot and /or photographer and submitted to the Program Director of the Photogrammetry Section. All project DES numbers shall be clearly denoted on all flight logs submitted to the Photogrammetry Section.

7.1.3 Film Camera - The LASO Photogrammetry Section's aerial camera system shall be utilized for aerial photography acquisition missions to aid in the process of product uniformity. If the Photogrammetry Section is unable to acquire the needed aerial photography, it shall be assigned to a contracted consultant. It shall be the responsibility of the consultant to utilize an aerial camera system that is equal to or exceeds the accuracy of the aerial camera system employed by the Photogrammetry Section. The consultant shall also provide the technical specifications for the aerial camera system prior to any aerial photography acquisition. Once the system specifications have been submitted to the Photogrammetry Section, the Photogrammetry Section Coordinator shall issue written consent to utilize said aerial camera system for the aerial photography acquisition mission. Any aerial camera system used by a contracted consultant shall have a focal length that does not exceed 153 mm, shall have a camera calibration that is not older than 3 years and shall provide proof that the aerial camera system is accompanied by a Forward Motion Compensation system.

7.1.4 Aerial Film - All aerial photography acquisitions missions shall be collected using Agfa's Aviphot Color X-400 PE1 aerial film. This film base is a panchromatic negative maskless color film with high color saturation, designed for aerial photography from low to medium altitudes and provides better capability to acquire images in shadowed areas. All

consultants shall operate with the understanding that any Aerial Film or Contact Prints produced are the sole property of INDOT and shall not be used by the consultant for any other purpose, unless authorized in writing by INDOT. If aerial film is provided by the Land & Aerial Survey office to a consultant for the aerial photography acquisitions mission any unused film shall be returned at the conclusion of the aerial flight. If the consultant has provided the aerial film, it shall be submitted to the Photogrammetry Section at the completion of the aerial project.

7.1.5 Digital Aerial Sensors – All Digital Aerial Sensors used for any photogrammetric purpose must possess a current **USGS Digital Aerial Type Certification** that can be acquired by visiting the USGS website.

http://calval.cr.usgs.gov/digaerial/usgs-digital-aerial-type-certification/

7.1.6 Airborne GPS/IMU - When available and depending on project requirements the Airborne Global Positioning Systems and Inertial Measurement Unit technology shall be employed to supplement the aerial ground control. The INCORS network is to be utilized as the primary static ground GPS receivers. If needed, due to irregularity in the project shape, additional static ground GPS receivers can be used in the adjustment process. All determinations to use or not to use Airborne GPS/IMU shall be determined by the Photogrammetry Sections Certified Photogrammetrist prior to any aerial acquisition mission.

7.1.7 Flight Conditions - The acquisition of high quality Aerial Photography is dependent on several factors including cloud cover, snow cover, vegetation canopy, wind speeds, sun angle and equipment functionality. Below are the prominent variables that can impact the acquisition and quality of the aerial photography:

7.1.7a Weather - Day to day weather conditions in Indiana are hard to predict and can cause delays in the acquisition of the aerial photography. The optimal weather condition(s) for the acquisition of aerial photography would be clear skies, no winds and dry ground.

7.1.7b Seasonal - In Indiana the most favorable window for Design Scale Photography is from March 1 to November 30, during which time the sun angle is greater than 30 degrees, allowing for enough reflective light to minimize the effects of long shadows. During the winter months of December-February Preliminary/Planning Photography can be acquired, if needed, depending on what planimetric features need to be visible, and when weather conditions are favorable. To determine what the exact sun angle is for any given time of the day in Indiana the following web site may be referenced:

http://www.srrb.noaa.gov/highlights/sunrise/azel.html

7.1.7c Vegetation - Spring is the best time for the acquisition of Design Scale Photography, because the deciduous trees haven't budded and the tall weeds and grass areas have been packed down from the winter snow. This is not to say that late fall wouldn't suffice for an aerial photography acquisition, as long as the leaves are off the trees and the majority of crops have been harvested. In both spring and fall acquisitions there shall not be any snow cover.

7.1.8 Aerial Mission Planning - All of the Aerial Photography Acquisition Mission Planning shall be performed by the LASO's Photogrammetry Section's Aerial Specialist or coordinated through the Aerial Specialist if the acquisition mission has been contracted to a consultant. If the mission planning is completed by the consultant, it is mandatory that the consultant submit a visual reference to the LASO Photogrammetry Section prior to the actual acquisition mission. Once the LASO Photogrammetry Section has received the aerial acquisition visual reference from the consultant, the Photogrammetry Sections Coordinator shall give written consent to the consultant to proceed with the Aerial Photography Acquisition Mission.

7.1.9 Flying Height - All Design Scale Aerial Photography shall be flown at one thousand two hundred feet (1200') above ground elevation. The flying height for Design Scale Photography shall not deviate more than +/- 5 percent (+/-5%) from the original one thousand two hundred feet (1200') above ground elevation. Preliminary/Planning Photography flying height shall be specified by the Department making the request for photography. All Aerial Photography collected shall be inspected by the Aerial Specialist for proper flying height, tip, tilt and crab. Any photography that deviates more than +/- 5 percent (+/-5%) from the original flying height shall be rejected. If Aerial Photography is rejected it shall be the responsibility of the consultant to re-acquire the needed photography at no additional cost to INDOT.

7.1.10 Coverage, Crab, Tip and Tilt - After the Aerial Photography has been acquired and processed, the Aerial Specialist shall inspect the aerial film to verify that the area originally requested was collected with sufficient coverage and that the crab, tip and tilt are to specification. The crab of the Aerial Photography can be compensated by the aerial camera system to a certain degree, but the allowable amount of crab cannot be greater than 3 degrees. If the crab is greater **than 3 degrees for two or more** consecutive aerial frames, that portion of the Aerial Acquisition Mission shall be rejected. The same can be said for the tip and tilt within the aerial frames. If the tip and tilt in a single aerial frame is greater than 4 degrees, this frame and any other aerial frames that are affected shall be rejected. If any Aerial Photography is rejected it shall be the responsibility of the consultant to re-acquire the needed photography at no additional cost to INDOT.

7.1.11 Photo Scale - 1:2400 (1"=200') is the Photo Scale used for all Design Scale Photography collected for the LASO Photogrammetry Section. All other Preliminary/Planning and Oblique photo scales shall be determined as required by requested geographic details.

7.1.12 Photo Overlap - The most commonly used average for the forward or endlap of the photography is 60 percent (60%) of the image frames. This shall be the preferred percentage of endlap for all photography collected for the Photogrammetry Section regardless of photo scale. The allowable limits of deviation in the endlap will be no less than 57 percent (57%) and no greater than 65 percent (65%). If the endlap differs from these percentages, the Aerial Photography shall be rejected. In addition to the endlap, any project that has adjacent or parallel flight lines shall need to have a preferred minimum of 30 percent (30%) sidelap. In areas with increased terrain relief the minimum sidelap shall need to be increased to no less than a preferred 35 percent (35%) sidelap. The allowable limits of deviations in the sidelap shall be no less than 20 percent (20%) for areas with little terrain relief and no less than 25 percent (25%) for areas with greater terrain relief. If the sidelap differs from these percentages the Aerial Photography shall be rejected. Rejected

Aerial Photography shall be the responsibility of the consultant to re-acquire the needed photography at no additional cost to INDOT.

7.1.13 Blank and Test Frames - At the end and the beginning of the Aerial Acquisition Mission there shall be no less than 4 tests and blank frames included with the aerial photography. These test and blanks frames are needed by the aerial film processing company to ensure the ability to process the aerial film to it greatest potential.

7.1.14 Film Processing – After the Aerial Acquisition Mission is completed the consultant shall ship the aerial film to:

Aerial Photo Lab, Inc.
200 Fentress Blvd., Suite D
Daytona, Beach Fl. 32114
P-(386)253-5041
F-(386)253-5031

Once the aerial film has been shipped to Aerial Photo Lab, Inc. by the consultant, the consult shall contact the Coordinator of the LASO Photogrammetry Section to confirm that shipping has occurred and provide a tracking number for accountability. At this point the Photogrammetry Section shall contact Aerial Photo Lab, Inc. in regards to return shipping directly to the Photogrammetry Section. Once the processed film has been received by the Photogrammetry Section's Coordinator, the Aerial Specialist shall begin the process of verifying that the aerial film has met all requirements.

7.1.15 Aerial Film Annotation - The aerial camera system shall be configured to imprint the following information on the aerial photography for any given aerial acquisition mission:

Date and time the photo was taken, Project DES number, Flight line number, Frame number, Latitude, Longitude, Photo Scale, Altitude (ASL)

Any and all annotation shall be required to be imprinted by the aerial camera system. The Photogrammetry Section shall not accept any aerial film that has this information annotated "by hand" and it shall be the responsibility of the consultant to re-acquire the needed photography at no additional cost to INDOT.

7.2 Aerial Photo Ground Control

7.2.1 General - The Photogrammetry Section makes every effort possible to make sure that the Aerial Photo Ground Control data that is used for any given project is held to the highest accuracy standards.

7.2.2 Photo Control Placement/Layout - The photo control placement/layout for all Aerial Photogrammetric projects shall be performed by the Lead Photogrammetrist in the LASO Photogrammetry Section. The computation of the aerial triangulation solution is one of the primary responsibilities of the Lead Photogrammetrist and shall ultimately be held responsible for the accuracy of the final solution. Due to this fact it is in the best interest of the Photogrammetry Section to have the Lead Photogrammetrist specify where and how many photo control points are required. Once the Lead Photogrammetrist has determined

the specific number and spatial distribution of the photo control points, the determination shall then be made if the control placement needs can be completed by the LASO Survey Section or if there is a need for part or all of the control work to be delegated to a survey consultant. After the determination of any delegation of services it shall be the responsibility of the Lead Photogrammetrist to provide the supporting placement documentation to the consultant or Surveying Section to aid in the proper placement of all photo control.

7.2.3 Datum and Coordinate System - All project control and mapping performed for INDOT shall meet the following positioning parameters unless otherwise directed by the appropriate District Survey Operations Manager:

1) **Vertical Positioning** – provide the vertical position using the following:

   i. Orthometric Height Datum –NAVD88
   ii. Geoid Model – GEOID12a

2) **Horizontal Positioning** – provide the horizontal positions using the following:

   i. Coordinate System - Indiana State Plane
      1. East or West Zone as appropriate
      2. Combined Scale Factor from grid to ground as appropriate
   ii. Map Projection – Transverse Mercator
   iii. Reference Frame – NAD83
   iv. Ellipsoid – GRS80

3) **Units and transformations** – Provide units in U.S. Survey feet. The U.S. Survey foot is defined as 1 meter = 39.37 inches. Use the following conversion factor:

   1 meter = 3.280833333 U.S. Survey feet.

   Perform all transformations in accordance with the NGS documented procedures.

7.2.4 Types of Aerial Photo Control - All Aerial Photo Ground Control targeting shall be located per the specifications outlined in Appendix A.

7.3 Digital Images

7.3.1 General - The LASO Photogrammetry Section utilizes the latest versions of photogrammetric image scanning hardware and software offered by the current vendor. The hardware and software allows the Photogrammetry Section to produce high quality digital images in a timely manner, while keeping the image files sizes to a manageable size. Digital Photogrammetric Imagery that needs to be produced for **Any INDOT** project shall be created utilizing the Photogrammetry Section's scanning technologies. This also includes all imagery production for projects which might be delegated to a contracted consultant.

7.3.2 Scanning Resolution - The standard scanning resolution for all Design Scale photography shall be 12.5 microns (2136 dpi). The most commonly requested scanning resolution for Preliminary/Planning Photography is 40 microns (636 dpi). Custom scan

resolutions can b**e** achieved, but shall need to be specified in writing by the person(s) or Department requesting services prior to scanning.

7.3.3 Image Compression - All Design Scale Imagery shall be produced with a JPEG compression factor 25 percent (25%). This shall aid in the manageability of mass amounts of digital imagery. The compression shall not affect **t**he overall high resolution requirements. Preliminary/Planning Digital Imagery shall not have a JPEG compression unless otherwise specified.

7.3.4 Image Overviews - During the process of creating the Digital Imagery, if needed, the Image Overviews shall be created and automatically embedded in the image files.

7.3.5 File Formats - The only acceptable file format for Photogrammetric Digital Imagery is the **TIFF** (Tagged Image File Format). All imagery shall be delivered in the **TIFF** format unless otherwise specified in writing. The Photogrammetry Section has the capability to convert Digital Photography to other needed file formats if necessary.

7.3.6 Delivery Medium - All Digital Images shall be submitted on portable media or DVD. All images shall be accompanied by all aerial acquisition or digital scanning documentation.

7.4 Aerial Triangulation

7.4.1 General - Aerial Triangulation is the mathematical process of establishing precise and accurate measurements between the individual aerial photos and a defined datum. All Aerial Triangulation (AT) shall be performed by the LASO Lead\Certified Photogrammetrist for all INDOT Aerial Photogrammetric projects, unless otherwise authorized by LASO. If the Aerial Triangulation is to be completed by a contracted consultant, it shall be completed by an ASPRS Certified Photogrammetrist and all results shall be submitted to the LASO Photogrammetry Section's Lead\Certified Photogrammetrist prior to any topographic mapping collection.

7.4.2 Imagery - The Aerial Triangulation process for all INDOT Aerial Photogrammetric projects shall be completed using high resolution color digital images, scanned at no less than 12.5 microns or 2100 dpi.

7.4.3 Camera Calibration - It is the responsibility of the consultant to submit to the LASO Photogrammetry Section, prior to image acquisition, a copy of the current Camera Calibration for the aerial camera system to be used. The camera calibration shall be no more than 3 years old, shall be performed by USGS, shall be on USGS letter head and signed by the authorized authority. Any other form of camera calibration **shall not** be accepted by the Photogrammetry Section. A copy of the Camera Calibration can be sent by mail, faxed or emailed to the Photogrammetry Section Coordinator.

7.4.4 Aerial Photo Ground Control - All Aerial Photo Survey Ground Control shall be submitted to the LASO Lead Photogrammetrist in the Photogrammetry Section. The required delivery format for the ground control file(s) is a digital ASCII file, with individual fields separated by a comma and those fields titled with PNEZD or PENZD. This will allow the Lead Photogrammetrist to import the control coordinates into the aerial

triangulation software. The electronic delivery of the control file will also aid in eliminating number transposition, instead of manually entering the control coordinates.

7.4.5 Airborne GPS/IMU - All Airborne GPS/IMU data collected for Aerial Photogrammetric projects shall be processed by the consultant that is responsible for the Aerial Acquisition Mission. Any supporting documentation or reports shall be submitted with the electronic GPS/IMU files to the Photogrammetry Section prior to the Aerial Triangulation process.

7.4.6 Interior Orientation - When performing the Interior Orientation for each individual photo in the Aerial Photogrammetric project the Lead Photogrammetrist shall measure all 8 photo fiducials and shall maintain the Acceptable RMSE Threshold which shall be no greater than 1.00 pixel or 12.5 microns per photo Interior Orientation.

7.4.7 Stereo Pair Measurements - It is standard Aerial Triangulation procedure for the Photogrammetry Section to measure no less than 8 Von Gruber (Pass Points) per stereo model. See Appendix B for a visual representation of what a "Normal" first model of any flight line will typically look like.

7.4.8 Stereo Point Measurement ID's - The standard naming convention for all Pass Points measured for any Aerial Triangulation project shall be *Flight Line ID_Photo ID_Point ID* i.e. *1_100_1*. All Aerial Photo Control Point ID's will already be predefined, but the point ID's shall range from 0700 to 0999.

7.4.9 Aerial Triangulation Solution Results - The following is the minimum required Triangulation Results for all Design Scale Photography:

Relative Orientation Sigma = 3.5 microns or less
Absolute Orientation RMS = 0.075 of a foot or less
Overall Sigma a priori = 4.5 mic**r**ons or less

Overall RMS for X, Y, Z = 0.075, 0.075, 0.05, respectively, of a foot or less

In addition to the above overall results the Stereo Point Measurements shall **not** include Blundered Points, Single Ray Point, or Two Ray points. These points shall be deleted from the final Aerial Triangulation solution.

All Aerial Triangulation Solutions shall be conducted and/or reviewed by an ASPRS Certified Photogrammetrist. The Certified Photogrammetrist shall also be required to Stamp and Sign all Result Reports that are created and submitted to the Photogrammetry Section.

7.5 Supplemental Ground Survey

7.5.1 General - This is the process in which the Field Survey Crew shall be responsible for collecting specific topographic features that the Photogrammetry Section is unable to notate or visually collect before and after the Aerial Data Compilation is completed.

7.5.2 Specific Supplemental Features - Appendix C contains a detailed list of items that all Field Crews shall be required to collect.

7.5.3 Topographic Collection Procedures - All Supplemental Field Survey Data shall meet the requirements as outlined in the INDOT Design Manual, Part I, Chapter 106 (Previously identified as Part III "Location Surveys", Chapter Twenty-Three) or current INDOT Survey Manual.

http://www.in.gov/indot/design_manual/2284.htm

If any part of the submitted Field Survey data does not meet the INDOT specifications, the originating provider shall make all necessary changes and re-submit until all data meets specifications at no additional cost to INDOT.

7.6 Digital Stereo Compilation

7.6.1 General - This is the process in which the Photogrammetry Section shall utilize the overlapping aerial photography to create the 3D environment that will allow for the collection of all project specific topographic features. The creation of a 3D environment allows the staff of the Photogrammetry Section to produce the Digital Terrain Models that represent the ground surface topography or terrain in a pre-defined area. **All INDOT** projects that have an **Aerial/Ground Combination Survey** component shall be submitted to the LASO Photogrammetry Section for services, unless otherwise authorized by LASO. Once the requested products for any given project have been indentified, LASO shall make the determination, if needed, to allocate any or all project needs to available contracted consultants, to include the Stereo Compilation component.

7.6.2 Horizontal & Vertical Aerial Mapping Accuracies - All INDOT Aerial/Ground Combination Surveys horizontal & vertical accuracies shall meet or exceed the **ASPRS Class 1 Accuracy Standards For Large-Scale Maps Part 1 & 2 March, 1990**. These published standards can be located at:

http://www.asprs.org/a/society/committees/standards/1990_jul_1068-1070.pdf

If these accuracy standards are not met by the contracted consultant, it will be the responsibility of the Certified Photogrammetrist to rectify **ALL** inaccuracies at no further cost to INDOT. Once the inaccuracies have been rectified, all Aerial Mapping shall be resubmitted to the LASO Certified Photogrammetrist for final review.

7.6.3 Design Files - All Digital Stereo Compilation shall be collected using Microstation V8i or the current CADD software in use by INDOT. It shall be required that the **INDOT_Imperial_SVFT_seed.dgn** seed file be used for the creation of the individual Model files for each Stereo pair of Aerial Photography. This seed file can be downloaded from the INDOT CAD Home page at:

http://www.in.gov/indot/design_manual/

7.6.4 Design Files Naming Convention - All Stereo Compilation Models shall be named as follows:

Road#_Flight Line #,Left Photo #_Flight Line #, Right Photo #
For example: *SR57_216_217.dgn*

All Model files that do not follow this naming convention shall be rejected when delivered and shall need to be renamed before resubmission. At the conclusion of the aerial compilation all individual Stereo Compilation Model files shall be delivered to the LASO Photogrammetry Section.

7.6.5 Stereo Model Boundaries - The Model Boundary for each individual Stereo Model shall be defined by a rectangular polygon placed by the Photogrammetric operators. The Model Boundary shall be produced in reference to the Main Project Mapping Limits and shall be required to encompass only the overlapping 3D photography between adjacent Fiducials.

7.6.6 Linear & Symbolic Digitizing Parameters - Appendix D outlines the proper Linear and Symbolic descriptions for compilation in the INDOT InRoads Workspace. If the compilation process is to be completed by a contracted consultant, it shall be mandatory that all of the Linear and Symbology Elements are set to the INDOT Workspace parameters to ensure Aerial/Ground uniformity. This uniformity will also aid in the process used to merge the Supplemental Ground Survey and the Aerial Data Compilation at a later date with NO data transformations needed. It shall be mandatory that all INDOT Field Survey Crews, Photogrammetry Section and all contracted consultants adhere to these Digitizing Methods. In addition, all items shall be digitized at the ground elevation unless otherwise stated. All Linear and Symbology parameters that differ shall be rejected and it shall be the responsibility of the consultant, field crew, Photogrammetrist, or compiler to fix the data for resubmission at no additional cost to INDOT. During the compilation of any INDOT project should the consultant have any questions regarding the procedures they are to contact the Lead Photogrammetrist or the INDOT CAD Department

7.6.7 Cell Library - Appendix E contains the Table that visually represents all of the Cells used in the INDOT InRoads Cell Library. These cells are utilized for the Aerial/Ground Combination Surveys. To ensure Aerial/Ground uniformity, it shall be mandatory for all contracted consultants performing compilation that all digitized cells match the INDOT Cell Library. This uniformity will also aid in the process used to merge the Supplemental Ground Survey and the Aerial Data Compilation at a later date with NO
data transformations needed. All digitized cells that differ from the table below shall be rejected, and it shall be the responsibility of the contracted consultant to correct the data for resubmission at NO additional cost to INDOT.

7.7 Orthorectification Images

7.7.1 General - This section outlines all requirements for any Orthorectification Imagery produced. If the Orthorectification process is to be completed by a contracted consultant the following minimum standards shall be adhered to. If not, all data that differs shall be rejected and resubmitted at no additional cost to INDOT.

7.7.2 Datums and Coordinates - All Ortho Imagery for INDOT Roadway Design projects shall be projected in the INDOT Project Coordinate System that has been previously defined for the Aerial Triangulation and Digital Compilation Process. If the Ortho Imagery is for a Non Design related project, all imagery shall be projected in State Plane North American Datum of 1983 (NAD83) unless otherwise specified by LASO.

7.7.3 Radiometric Balancing - When a mosaic of two or more images is made, the brightness and color values of the other images shall be adjusted to match that of the principal image. The seamlines between the overlapping images shall be chosen to minimize tonal variations. Localized adjustment of the brightness and color values shall be done to reduce radiometric differences between adjacent areas. Changes in color balance across the project, if they exist, shall be gradual. Abrupt tonal variations between image files are not acceptable. These images shall be rejected and resubmitted at no further cost to INDOT.

7.7.4 Edge Matching and Overlap - Excessive horizontal displacement along seamlines or at image file boundaries shall not be permitted**.** The maximum allowable mis-join between transportation features or other well defined linear features is ±3 pixels. All Orthorectified Images shall overlap adjacent images with an overlap distance of no less than fifty feet (50'). Any Images that do not meet the required overlap distance shall be rejected and it shall be the responsibility of the contracted consultant to rectify the errors and resubmit the files in question to LASO at no additional cost to INDOT.

7.7.5 Resolution - The color final Orthorectified Imagery files shall be rectified to a ground pixel resolution of no greater than twenty-five hundredths of a foot (0.25'). If the final pixel resolution is not adhered to, all files that do not conform shall be rejected and shall be resubmitted to LASO at no additional cost to INDOT.

7.7.6 Horizontal Accuracy - Ortho Imagery accuracy shall be determined using all Surveyed Control point and all Digitized CAD data. If any portion of the Orthorectified Image is horizontally inaccurate by more than five hundredths of a foot (0.05'), that Image will be rejected and shall be corrected and be resubmitted to LASO at no additional cost to INDOT.

7.7.7 Image Format - Images shall be submitted in a compressed (near lossless), un-tiled, Geo-rectified TIFF format. Each Image shall also be accompanied by the corresponding TIFF World File.

7.7.8 File Naming Convention - For projects in INDOT Project Coordinates file names for the 4000 x 4000 ft ortho image files shall be derived from the southwest corner of each image. The file name shall consist of the X and Y INDOT Project coordinate of the south-west corner. For projects in State Plane/feet, file names for the 4000 x 4000 ft ortho image files shall be derived from the southwest corner of each image. The file name shall consist of the X and Y State Plane coordinate of the south-west corner. All Ortho Image corner coordinates shall be whole numbers preferably ending in "**5**" or "**0**", any decimal or non whole number coordinated shall be rejected.

7.7.9 Quality Control - A visual inspection of Orthorectification Images shall be performed by the photogrammetry staff to ensure that all Orthorectification products produced by the contracted consultant adhere to LASO Specifications. The following is the criteria that LASO shall utilize for the inspection of all Orthorectification Images.

- Completeness of data to cover the specified geographic extent, with no omissions or corrupt data.
- Tonal balancing problems across the block.

- Ground Sample Distance to ensure that it meets the specified resolution.
- Mis-joins between linear features greater than 3 pixels.
- Cloud cover, smoke/haze, corrupt data, and void areas.
- Extreme tonal or color variation across seamlines.
- Excessive horizontal displacement along seamlines in images (more than ±3 pixels along transportation features).
- Excessive tilt in bridges, buildings, and other raised features.
- Transportation features that are obstructed by buildings or shadows.
- Tall buildings in urban areas that obscure features in the interior of a city block.
- Clipping of features (e.g. radio towers, water tanks, buildings) at image file boundaries.
- Building/structure, bridge, or road warp that may indicate bad elevation data.
- Smearing.
- Evidence of oversaturation or under-saturation as a result of image processing or histogram manipulation.
- Evidence of image compression.

All Orthorectification Imagery that doesn't pass any of these criteria shall be rejected. It shall be the responsibility of the contracted consultant to rectify the errors and shall resubmit the files in question to the Land & Aerial Survey Office at no additional cost to INDOT.

7.7.10 Delivery Medium and Format - Digital Orthorectified Images shall be submitted on portable media or DVD. Image files shall be accompanied by an index sheet and DGN file suitable for loading into Microstation.

7.8 InRoads Files to be delivered

7.8.1 General - This section outlines the InRoads data files that INDOT requires to be delivered with all Aerial/Ground Combination Survey or Traditional Ground Survey projects.

7.8.2 File Requirements - All INDOT InRoads projects require that the final Aerial topography files be delivered in a certain file format and naming convention. Appendix F outlines all files that shall be delivered to the Land & Aerial Survey Office for all survey projects. If the final Aerial topography files are NOT delivered in the proper file format or don't adhere to the proper naming conventions all files shall be rejected and shall be resubmitted following the guidelines at no additional cost to INDOT.

7.8.3 Acceptable Delivery Medium - All INDOT InRoads project files shall be delivered on CD or DVD, clearly labeled to depict all Aerial files being delivered and in an adequate jewel case for storage. If any or all of the requirements are not adhered to, LASO shall reject the delivery of the final project files. All rejected files shall be resubmitted at no additional cost to INDOT.

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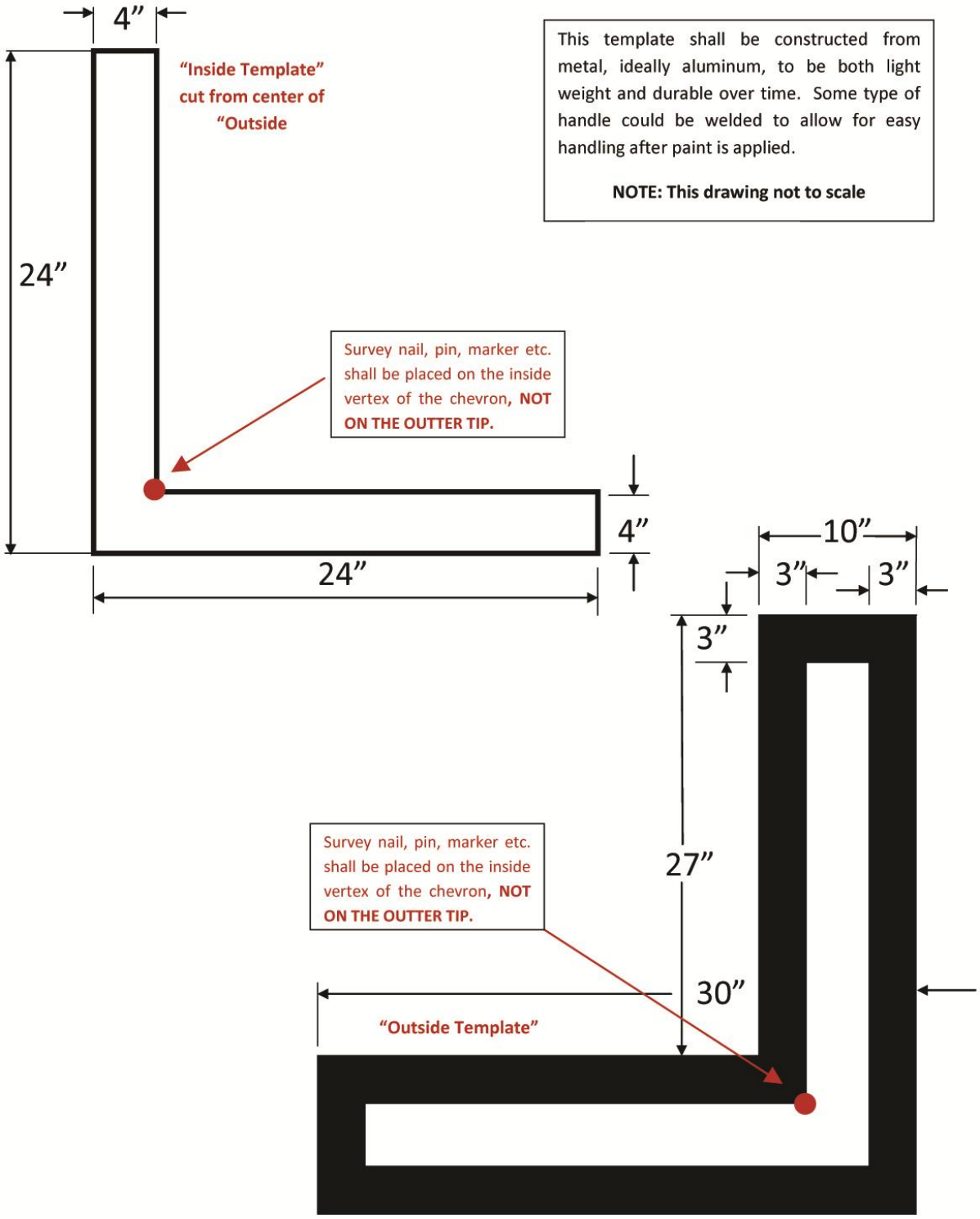
Appendix A

Land & Aerial Survey Office (LASO) Aerial Photo Ground Control

INDOT will provide the desired Lat/Long locations of the photo control points in a .gpx file that can be uploaded into a handheld GPS unit. If requested, an ASCII file with panel locations listed in latitude and longitude can be provided. This location information will be used to place the panel points prior to the aerial photography being flown. The panel points need to be of high contrast as compared to their background (either light color placed on a dark background or vice versa). Additionally, they will be placed such that they are not blocked from above by any overhanging features (trees, buildings, etc.). Also they should not be placed on a significant sloping surface.

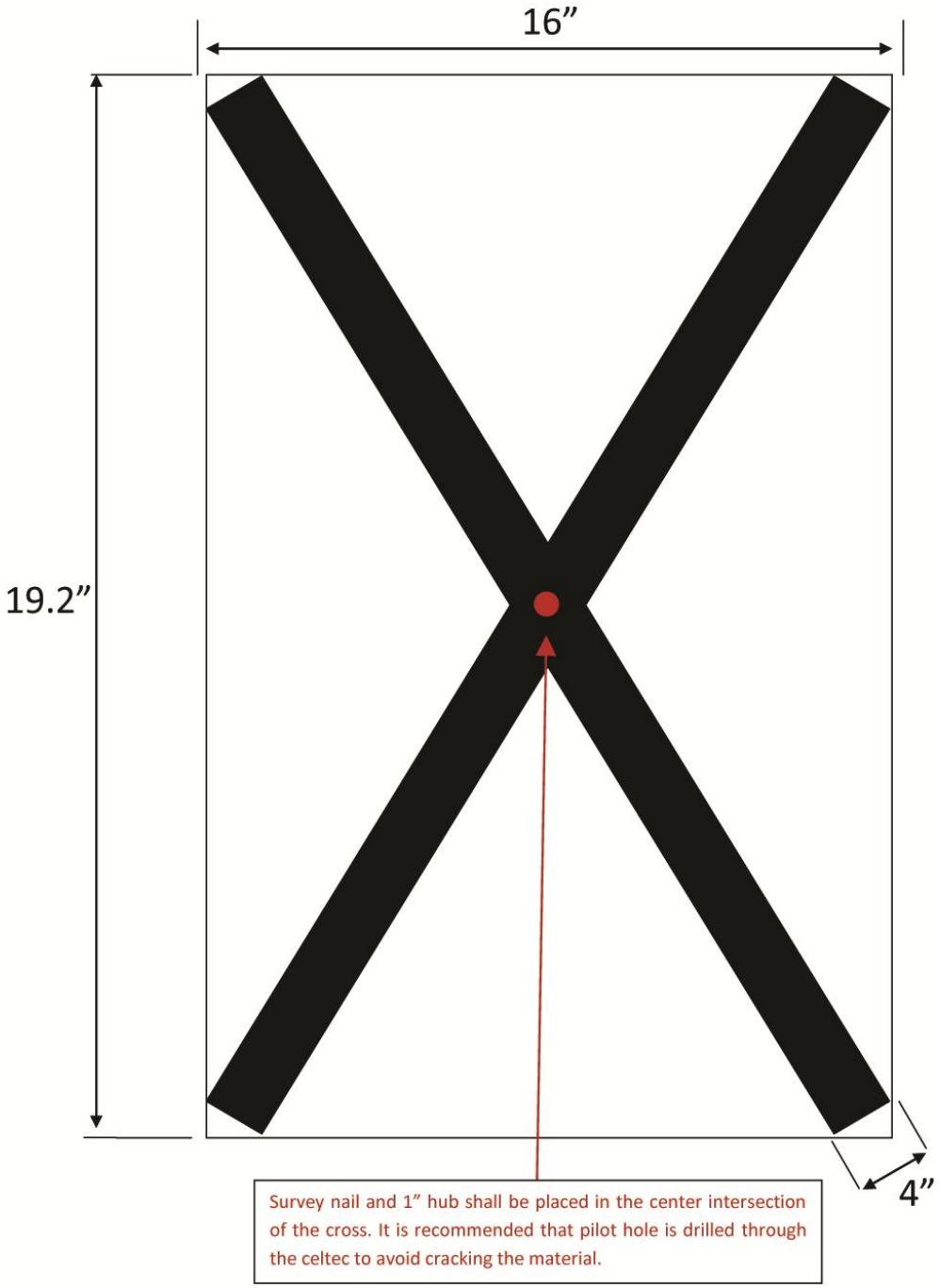
Chevron type panel point - Where possible, the preferred panel point style will be painted on hard surfaces (e.g. pavement, concrete) in the shape of a chevron ("V"). The legs of the chevron will be at least 24 inches in length, and the legs will be at least 4 inches wide forming a 90° angle. The **inside corner of the chevron** is the XYZ "origin" point for this style of panel point (see diagram below).The field survey crews will need to create the necessary templates for this type of panel. Once the field crew has created the panel templates, the field person(s) can navigate to the desired panel location, drive a nail into the surface and then, using a small brush or broom, clean the surface area of any debris. The field person shall then lay the outside template such that the inside corner is located directly over the nail and then paint the entire chevron surface (**White** paint is mandatory). Once the chevron is sufficiently dry, the outside template can be removed and the inside part of the template can be placed directly over the white chevron. Black paint can now be sprayed around the insert, leaving a black outline around the newly painted white chevron. After the painting of the chevron has occurred the field person will need to use either pink or orange marking paint to label the chevron with the provide photo control point number. These numbers need to be painted within 2 feet of the panel and the numbers need to be at least 6 inches tall. See visual representation on page 22:

Chevron Type Panel Template



Cross type panel point - Where there is not a suitable surface to paint on, the cross type panel point shall be constructed by adhering black weather resistant film to a white plastic material (Celtic material is strongly recommended). This type of panel point is temporary, and is the less desirable style of panel points. Recommended construction of these panels can be completed by taking a 3/8" thick, 48" by 96" sheet of Celtic and cutting it into pieces that approximately measure 16" by 19.2". First cut the 48" wide sheet into three 16" wide strips, and then cut the 96" long strips into five equal pieces (approximately 19.2" long). This will yield 15 panels per each 4' by 8' sheet. The cross is then made by placing a 4" wide black weather resistant film from each opposing corner of the Celtic panel (see diagram below). In the field, drive a 1" by 1" by 12" hub stake into the ground so it is flush, and then fasten this panel to the hub stake with a nail driven through the center of the cross. The center of the cross will be the XYZ "origin" point for this style of panel point. See visual representation on page 24:

Cross Type Panel Template



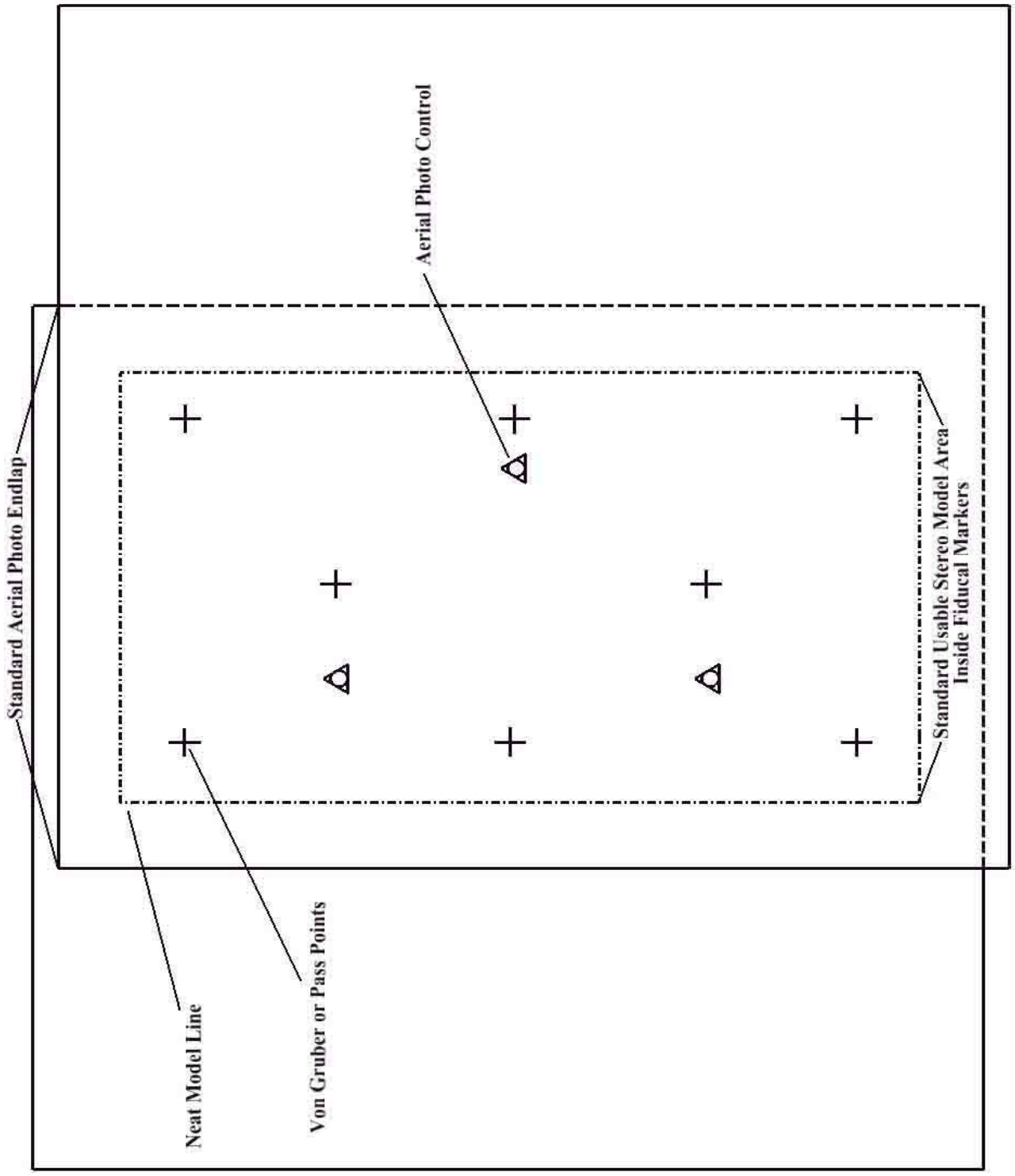
Consultants - Materials for producing this style of panel point are available through the following supplier:

The Plastic Center (A division of Myer Plastics)
5167 E. 65th St. Indianapolis, IN. 46220-4816
317-634-4528

Districts - Please contact the survey section of LASO to obtain these materials.

Important note regarding the movement of panel points - No control point should be moved more than 50 feet from its original projected location without first contacting INDOT's LASO staff. When contacting LASO regarding a desired panel point move, please indicate the point ID number, and the desired direction and distance of the proposed move. If there are any questions about the panel points please do not hesitate to contact the Lead Photogrammetrist within LASO Chip Campbell at 317-610-7251 ext.298

Appendix B
Stereo Point Measurements



Appendix C

Specific Supplemental Features

When conducting supplemental ground surveying, feature and location data information will be collected on, but not limited to, the following, unless otherwise determined unnecessary based on project scope by the LASO Photogrammetry Section:

- Items not observable or obscured on aerial imagery (e.g. under canopy, under bridge deck, etc).
- Utilities to include, but not limited to, surface indications and markings of subsurface utilities, pedestals, poles, etc…, with identifying annotations.
- Inverts of pipes with notes of size & material type.
- Ditch lines, concrete paved side ditches, intermittent streams, creeks and stream flow lines that may be obscured with vegetation or canopy. Continue strings under bridges when present.
- Individual trees 4" in diameter or larger (DBH) with annotation of size & species. For forested or dense wooded areas, locate area limits and note prevailing size or range.
- Manholes with pertinent feature data (e.g. material type, size, depth, flow lines of pipes coming in or going out, sizes and shots on directions of pipes coming in or going out).
- Storm Inlets (curb and other) with all pertinent feature data.
- PMAT (material type) shots where needed.
- Signage with annotation as to type, support size, and information represented.
- Mailboxes with annotation as to type and number of boxes, and type and size of mount/support.
- Buildings, walls, fences, and other improvements as needed, located at grade.
- As accurately as the evidence permits, the location of cemeteries, gravesites and burial grounds observed.
- Items that require P (point) or S (line) notes.

Note:
In order to maintain cost effectiveness, it should be noted that the primary purpose of the supplemental ground surveying is to identify and collect data on features that cannot be collected from aerial photography (i.e., covered, obscured, or sub-surface). If features are clearly visible from the air, some information may not need to be collected directly on the ground to ensure efficient use of ground field work.

During the aerial survey stereo-compilation process (mapping), there may be a need for additional ground survey information to be collected in any areas that were obscured in the aerial photography. In those cases, the Land & Aerial Survey Office will provide the necessary information, in most cases to the original ground survey crew(s), in order to have the remaining feature data collected.

Appendix D

InRoads Files to be Delivered

Considering that INDOT has adopted Microstation and InRoads as its standard drafting and design software applications, respectively, the CAD Support Team has developed standard resource files such as design templates (seed files) and survey-data processing (.xin) files. The most current INDOT *seed.dgn* and *survey.xin* files made available through the CAD Support Team shall be used.

The Department has established a standard naming convention for all InRoads survey files to make the data more portable so that all users can easily recognize and use the files created by others. The conventions also provide information on file contents at a glance. Each InRoads survey file submitted to INDOT shall use the format and provide the content as described below.

DES#_SRxx Name.extension

Key:
DES#: designation number for project as provided by INDOT
SRxx: route number of project, for example: SR37, SR162, I64, US150
Name: descriptive name of information in file, for example: Topo, LCRS Plat
Extension: file extension name, for example, .xin, .dgn, .fwd

The files to be submitted to INDOT for each survey are as follows:

1. Des #_SRxx Control Points.fwd
2. Des #_SRxx LCRS Plat.pdf
3. Des #_SRxx LCRS Plat.dgn
4. Des #_SRxx Survey Alignment.alg
5. Des #_SRxx Survey Book.docx
6. Des #_SRxx Survey Surface.dtm
7. Des #_SRxx Survey Surface Boundary.dtm
8. Des #_SRxx Survey.xin
9. Des #_SRxx Topo.dgn
10. Des #_SRxx Topo.fwd
11. Des #_SRxx seed.dgn

26-1.01(01) Minimum File Requirements [Rev. Aug. 2013]

Each file shall include, at a minimum, the data described below.

1. Des # SRxx Control Points.fwd. This file includes all centerlines, a partial list of fly stations (random control points), bench marks, and United States Public Land Survey (USPLS) subdivision corners, including corners of properties not within USPLS areas, necessary to describe acquisition parcels.

a. Centerline. All centerline points of each survey line within the survey shall be included in this file.

(1) The code for centerline points shall be "PSSA".

(2) Notes for each "PSSA" shall include location (e.g., POT, PC, POST, etc.) stationing, line letter, PI information (delta angle, degree of curve or radius length, tangent length, arc length, and external length), description of monument, and location of top of monument relative to ground surface or pavement surface.

b. Fly station. All fly stations traversed through, during establishment or reestablishment of survey lines, shall be included in this file. All fly locations set during topographic collection shall not be in this file, but shall be included in the "Des #_SRxx Topo.fwd" file.

(1) The code for fly station shall be "FLY".

(2) Notes for "FLY" shall include the description of the monument and location of top of monument relative to ground surface or pavement surface for each point.

c. Bench Marks. These used for survey data collection shall be included in this file.

(1) Monuments shall be coded in accordance with the .xin file provided by INDOT.

(2) Bench-mark notes shall include the name and description of each monument, a description of the structure that the monument is placed in or on, the station and offset from the survey line, and the survey-line letters.

Examples: BM#1, Boat Spike in root of 21-in. oak tree, 125 ft left of Station 123+45, Line "A". INDOT BM 19 V 1030, disc in north end of concrete headwall, 55 ft right of Station 35+25, Line "S-1-A".

d. USPLS Corners. These, or corners of properties not within USPLS areas, necessary to describe acquisition parcels, shall be included in this file.

(1) Monuments shall be coded in accordance with the .xin file provided by INDOT.

(2) Notes for monuments shall include the location of the corner.

Example for area within USPLS: "N ¼ Corner of Section 34, T2N, R2W". Example for area not within USPLS: "NE Corner of Division "C" of the Vincennes Commons Lands".

(3) Notes shall include a description and location of each monument relative to the ground surface or pavement surface.

2. Des #_SRxx LCRS Plat.pdf. This file is a copy of the Location Control Route Survey Plat (LCRS) as recorded in the County Recorder' office, for the survey project. This copy shall have the seal and signature of the Licensed Land Surveyor in responsible charge, and all recording information placed on the LCRS by the County Recorder.

3. Des #_SRxx LCRS Plat.dgn. This Microstation file shall include multiple models of the following.

a. The LCRS used to generate that for recording with the County Recorder. This shall be provided for design reference and use.

b. Survey control points and references, which include the following:

(1) description of point along alignment (e.g., POT, PC, POST, etc.);

(2) stationing of survey-line point (e.g., 123+45.67, etc.);

(3) line letter (e.g., "A", "S-1-A", etc.);

(4) description of monument (e.g., 5/8 in. rebar with cap stamped INDOT 0005, Mag Nail with washer stamped INDOT 0005, etc.);

(5) location of top of monument relative to ground surface (e.g., Flush with surface, 0.1 ft below ground surface, protruding 0.4 ft above ground surface, etc.);

(6) description of reference monument (e.g., Nail in Bottle Cap in 15-in. Maple, Nail in Bottle Cap in Corner Fence Post, X Cut in Concrete Headwall, etc.); and

(7) azimuth to nearest degree, and distance to nearest 0.01 ft, from control monument to reference monument.

c. USPLS corners, or corners within areas not part of the USPLS, and references, including, at a minimum, the following:

(1) descriptions of USPLS corners (e.g., W ¼ Corner of Section 24, T3N, R5W);

(2) descriptions of monuments not within USPLS areas (e.g., NE Corner of Division "C" of the Vincennes Commons Lands);

(3) description of monument (e.g., 9" x 6" stone with "S 24 W ¼" cut on side of stone);

(4) location of top of monument relative to ground surface (e.g., Flush with surface, 1.5 ft below ground surface, protruding 0.7 ft above ground surface, etc.);

(5) description of reference monument (e.g., Nail in Bottle Cap in 15-in. Maple, Nail in Bottle Cap in Corner Fence Post, X Cut in Concrete Headwall, etc); and

(6) Azimuth, to the nearest degree, and distance, to the nearest 0.01 ft, from control monument to reference monument.

4. Des #_SRxx Survey Alignment.alg. This file includes all alignments of the survey project.

a. In writing Survey ("Des #_SRxx Control Points.fwd") to Geometry, in the "Project Name" box, enter "Survey Alignment".

b. In creating alignment, in "Name" box, enter "A" for Line "A", etc.

c. If there is an "S" line, under "Survey Alignment", name alignment "S-1-A", "S-SRxx-A", etc.

d. For the description of each alignment, use the applicable route name (e.g., SR 1, CR 250 W, etc.).

e. The alignment shall have the correct stationing applied.

f. Save as "Des #_SRxx Survey Alignment.alg"

5. Des #_SRxx Survey Book.docx. This file includes all supplemental survey information not found in other files. The .docx format is preferred. However, .doc or .pdf is also acceptable. It shall include the following:

a. front page notations, i.e., Des No., Route No., Terminal Points of Project, County, brief description of each line;

b. title page and completed Table of Contents;

c. dates of survey start and survey completion;

d, names of survey crew members;

e. Des number and page numbers at top of each page;

f. Surveyors Report, in accordance with IAC-865, as a minimum requirement;

g. start and end of each line shown with equations and cross references to other surveys;

h. control points labeled, with location (e.g., POT, PC, POST, etc.), stationing, line letters, location relative to surface (e.g. flush, 0.1' below ground level, etc.), and coordinates shown;

i. alignment data shown and checked;

j. references shown and checked, if LCRS not prepared. If an LCRS was prepared, this information will be on the recorded LCRS;

k. source of bearings described;

l. utility ownerships within limits of survey, with mailing addresses, with a notation of utilities not within limits;

m. Underground Utility Reference Number placed on Utilities page;

n. high-water elevation and date, with source and date of information;

o. source of level datum;

p. bench-mark descriptions completed;

q. level notes for all bench marks used for survey;

r. legal flow-line elevations of county ditches; and

s. level equations with other surveys shown, and explained.

6. Des #_SRxx Survey Surface.dtm.

a. In writing Survey to Surface, in "Surface Name" box, enter "Survey Surface" and save as "Des #_SRxx Survey Surface.dtm".

b. For more than one surface within a survey project, use "Survey Surface A", etc. (see "Des #_SRxx Topo.fwd" below).

c. All string crossings shall be resolved.

d. Upon completion of the survey, with all corrections of field data completed, a "Survey Surface" shall be created. After determining this surface to be correct, create a boundary string named "Boundary" by connecting all points and strings along the exterior of the survey that are to be included in the triangulation. "Survey Surface" will contain the survey surface and the exterior "Boundary" feature. This surface shall be saved as "Des#_SRxx Survey Surface.dtm".

7. Des #_SRxx Survey Surface Boundary.dtm.

a. After creating the boundary string around the survey perimeter, as described in item 6d above, such boundary shall be saved in a separate surface file as "Des #_SRxx Survey Surface Boundary.dtm", which shall include only that feature.

b. For more than one boundary around a survey project, use "Survey Surface Boundary A" for the boundary of "Survey Surface A", etc. (see "Des #_SRxx Topo.fwd" file, item 9, below).

8. Des #_SRxx Survey.xin. This is the InRoads "xin" file used for the survey project. InRoads standards for survey data processing have been set up in this file. This file

includes the INDOT standards for Feature Codes, Feature Styles, and Feature Filters, Dialog Box Settings, Linestyles, Lineweights, colors, and other settings. This file is critical for use in the InRoads Survey Process, and for accurate DTM and geometry object creation. Additional Names Symbology or Styles should not be added in order for the .xin file to be consistent with the current MicroStation settings. Utilities will therefore function properly.

a. It shall be a copy of INDOT.xin, as provided by the CAD Support Team, at the time of project inception.

b. All modifications to .xin shall not affect the ability of submitted files (.dtm, .alg, .fwd) to interact with later versions of .xin in an error-free manner. Feature names, symbology, etc. shall not be changed.

9. Des #_SRxx Topo.dgn. Secondary display items, such as Contours, Triangles, and Survey Graphics, may be written to additional .dgn files and provided as references.

a. MicroStation files shall be used with InRoads for the survey project.

b. It shall be in accordance with the appropriate unitary system for the survey, i.e., US Survey Feet, seed files as provided by CAD Support.

c. The features to be displayed on separate levels, as defined by INDOT.xin, shall be as follows:

(1) DTM features;

(2) existing contours;

(3) existing triangulation;

(4) survey alignment with annotation;

(5) survey field-book data written to graphics, including symbols, names. elevations, notes, and codes.

10. Des #_SRxx Topo.fwd. This file includes all topographic data for the survey project.

a. All topographic data shall be included in one field book (i.e., Des #_SRxx Topo.fwd"). An exception is if there are isolated survey locations in a lengthy project, for example structure replacements in a resurface project, as discussed below.

b. Under "Survey Data" in InRoads, create a new book named "Des #_SRxx Topo".

c. Import the data collector (controller) or text file into InRoads to create a field book. Save the created field book as "Des #_SRxx Topo.fwd".

d. Data imported from a collector (controller) or a text file shall not have a file name containing more than 15 characters. A file name longer than this will be truncated within InRoads to 15 characters after the field book is saved and then loaded again at the next session. This is not the name of the field book as required in item 10c above, but it is the name of the data file used to create the field book.

e. If more than one survey site is included in the survey project, for sites that are not near each other, create a different .fwd file for each site. For example, for two or more small structure replacements in a resurface project, use "Des #_SRxx Topo A" for the first site (south to north, or west to east) and "Des #_SRxx Topo B" for the second site, and continue using the same procedure.

11. Des #_SRxx seed.dgn This file, in combination with the IN_GeoCS.dty and esri_cad.wld files, will be used for geo-coordination of CAD files by GIS products through the project lifecycle.

a. Procedures for the creation of this file are provided in the current version of the *DOTWiseX.X MicroStation, InRoads & ProjectWise for Survey and Design Manual* available on the INDOT CAD Support webpage.

b. Required template files referenced in the above instructional documentation are available on INDOT CAD Support webpage under the Geo-Coordination tab.

26-1.01(02) Additional Geo-Coordination Files [Added Aug. 2013]

Two additional files that are directly correlated with the DGN geo-coordination seed file shall also be included in the survey transmittal as follows:

1. IN_GeoCS.dty The delivered file will contain the appropriate coordinate systems.

a. This is the base customized geo-coordination library to be used with Bentley Map and the creation of geo-coordination survey seed files.

b. This file should be used with the MicroStation MS_GEOCOORDINATE_USERLIBRARIES variable.

c. The template file will be edited as necessary, and then saved.

2. esri_cad.wld This file contains the necessary parameters to transform the DGN to the State Plane Coordinate (SPC) system.

a. The data in this file allows the file to be re-projected on-the-fly to its appropriate location on the ground in the real world.

b. The data in the WLD file will consist of the Local Ground Coordinates for two well-established control points and the corresponding SPC for the same two points. The two control points should be located such that one is outside the limits of construction at the start of the project, and the other will be at a similar location beyond the end of the project construction.

Procedures for accessing, properly editing, and creating the above described files can be found in the current version of *DOTWiseX.X MicroStation, InRoads & ProjectWise for Survey and Design Manual* available on the INDOT CAD Support webpage. The required templates referenced in the instructional documentation are also available on the INDOT CAD Support webpage and are located under the Geo-Coordination tab.

26-1.01(03) Aerial-Survey File Requirements

1. All files created by an aerial survey shall follow the established InRoads survey file naming and technical conventions.

2. In naming these files, they shall have the suffix "_Aerial" appended at the end of the file name, prior to the file extension, i.e., "Des #_SRxx Topo_Aerial.fwd".

3. If a combination of aerial and ground surveys is submitted, they shall be combined into a single .dtm survey surface.

Appendix E - Linear & Symbolic Digitizing Parameters

Level Name Associated Cells	Level Digitizing Descriptions
S_BR_abutment	The substructure element supporting each end of a single span or the extreme ends of a multi-span superstructure and, in general, retaining or supporting the approach embankment. Also, digitize an additional level string at the ground elevation as needed.
S_BR_Bent	The substructure unit supporting each end of a bridge span; also called a pier; made up of two or more columns or column-like members connected at their top most ends by a cap, strut, or other member holding them in their correct positions.
S_BR_deck	The roadway portion of a bridge that directly supports vehicular and pedestrian traffic.
S_BR_exposed footing	The enlarged, lower portion of a substructure that distributes the structure load either to the earth or to supporting piles; the most common footing is the exposed concrete slab.
S_BR_Hand Rail	The top center of all Hand Rails.
S_BR_Overhead Ped Walkway	The outline of all Overhead Pedestrian Walkways.
S_BR_Seat	The top leading edge of all Bridge Seats.
S_BR_Wheel Guard	Top leading edge of the Wheel Guard on all Bridge Decks.
S_BR_Wingwall	The top leading edge of all Wing Walls, also place breakline at ground elevation outlining the Wing Wall.
S_CTRL_aerial cross	All Aerial Control Panels or Chevrons. This cell must be digitized in the inside of all Chevrons and the center of all Control Panels at ground elevation
S_CTRL_Bench mark	All Temporary Benchmarks. This cell must be digitized in the center of the benchmark.
S_CTRL_Boat spike	All Boat Spike Monuments. This cell must be digitized in the center of the Boat spike.
S_CTRL_Brass plug	All Brass Plug Monuments. This cell must be digitized in the center of the Brass plug.
S_CTRL_CheckShot	All field survey Check Shots.
S_CTRL_County Benchmark	All County Benchmarks. This cell must be digitized in the center of the benchmark.
S_CTRL_Countyline Marker	All County Line Markers. This cell must be digitized in the center of the marker.
S_CTRL_Drill hole in Conc	All Drill Holes found in Concrete. This cell must be digitized in the center of the Drill Hole.
S_CTRL_GPS control	All GPS Monuments. This cell must be digitized in the center of the GPS monument.
S_CTRL_INDOT BM	All INDOT, IDOH, ISHC Benchmarks. This cell must be digitized in the center of the benchmark.
S_CTRL_INDOT flood control BM	All DNR, IFC-WRC Benchmarks. This cell must be digitized in the center of the benchmark.
S_CTRL_Instr or alignmt	All Center Line Alignment control points. This cell must be digitized in the center of all control or instrument markers.
S_CTRL_Iron pin	All Iron Pins. This cell must be digitized in the center of the pin.
S_CTRL_Iron pipe	All Iron Pipes. This cell must be digitized in the center of the pipe.

S_CTRL_Mon	All Monuments that are not specifically designated in the INDOT workspace. This cell must be digitized in the center of the monument.
S_CTRL_Nails-MagNail	All Mag Nails. This cell must be digitized in the center of the nail.
S_CTRL_Nails-PkNail	All PK Nails. This cell must be digitized in thecenter of the nail.
S_CTRL_NGS triangulation sta.	All NGS Triangulation Stations. This cell must be digitized in the center of the NGS Station.
S_CTRL_Point-Fly Stations 1	All Survey Random Control Points. This cell must be digitized in the center of the Fly Station.
S_CTRL_Point-Resection Pts	All Survey Resection Points. This cell must be digitized in the center of the Resection Marker.
S_CTRL_Point-Traverse Pts 1	All Survey Traverse Points. This cell must be digitized in the center of the Traverse Marker.
S_CTRL_Railroad spike	All Railroad Spikes. This cell must be digitized in the center of the Railroad Spike.
S_CTRL_Rebar	All Size Rebar. This cell must be digitized in the center of the rebar.
S_CTRL_Road nail	All Road Nails. This cell must be digitized in the center of the nail.
S_CTRL_Section Cor traversp	All Section Corner Points. This cell must be digitized in the center of the Section Corner Marker.
S_CTRL_State line marker	All State Line Markers. This cell must be digitized in the center of the marker.
S_CTRL_Stone Mon	All Stone Monuments. This cell must be digitized in the center of the monument.
S_CTRL_USC and GS bench mark	All USC&GS Benchmarks. This cell must be digitized in the center of the benchmark.
S_CTRL_USGS bench mark	All USGS Benchmarks. This cell must be digitized in the center of the benchmark.
S_CTRL_Wood stake	All Wooden Survey Stakes and Hubs. This cell must be digitized in the center of the stake or hub.
S_DR_500UpDownStreamTopWater	All Up\Downstream Water Readings. This cell must be digitized at the surface above flow line. Note the depth.
S_DR_Catch basin	All non Round or Square Catch Basins. This cell must be digitized in the center of the grate.
S_DR_Catch Basin Round	All Round Catch Basins. This cell must be digitized in the center of the grate.
S_DR_Catch Basin Square	All Square Catch Basins. This cell must be digitized in the center of the grate.
S_DR_Conc paved side ditch	The top edge of any Concrete Ditch.
S_DR_Ditch line	The top leading edge for all Ditches.
S_DR_Drainage pipe	The Invert or Top of the opening for all pipes.
S_DR_Edge of gutter line	The Gutter Line of all Curbs.
S_DR_Header-bottom	The bottom leading edge of all Drainage Headers.
S_DR_Header-top	The top leading edge of all Drainage Header.
S_DR_Headwall	The top edge of Head Wall. Also place a Level String at ground elevation outlining the Head Wall.
S_DR_Inlet-curb	All Curb Inlets. This cell must be digitized in the center top of the leading edge and rotated to correct angle.
S_DR_Inlet-drop	All Drop Inlets, square or round. This cell must be digitized at the elevation of the grate.
S_DR_intermittent small strm	The flow line of Intermittent Stream.
S_DR_Ordinary High Water	All Linear Ordinary High Water Marks.
S_DR_Ordinary High Water	All Ordinary High Water Marks flags. If flag is numbered note the number.
S_DR_Retaining wall	The top leading edge of all Retaining Wall. Also place a Level String at ground

	elevation outlining the Retaining Wall.
S_DR_Sluiceway	All man-made channels designed to redirect excess water.
S_DR_Spillway	The outside edge of all drainage Spillways.
S_DR_Swamp symbol	All Swamps. This cell must be digitized at ground elevation.
S_DR_Swamp-marsh-wetland	All Wetlands, Swamps or Marsh out lines at ground elevation. Do not label as wetland, swamp or marsh.
S_DR_Water flow line	The Water Flow Line in ditches, streams, canals, etc.
S_DR_Waters edge	The edge of all water for rivers, lakes, ponds, etc.
S_PROP_Athletic Field	The outline of all Athletic Fields on school properties, college campuses, city parks, state parks, ect.
S_PROP_Billboard-metal	The top leading edge of all Metal Billboards.
S_PROP_Billboard-wood	The top leading edge of all Wood Billboards.
S_PROP_Bldg	All building foundations at the ground elevation.
S_PROP_Bldg-overhang	The edge of roof that hangs over the building foundations.
S_PROP_Bush	All Bushes. This cell must be digitized in the center of the Bush at ground elevation. The
S_PROP_Canopy Cor	The edge of any overhead Canopy Structure.
S_PROP_Car wash vacuum	All Vacuums located at car washes or gas stations. This cell must be digitized in the center of the vacuum at the elevation of the ground or concrete slab.
S_PROP_Cistern	All Cisterns. This cell must be digitized in the center of the cover.
S_PROP_Fence-barbed	The center of all Barbed Wire Fences. The fence must be digitized at ground elevation.
S_PROP_Fence-chain link	The center of all Chain Link Fences. The fence must be digitized at ground elevation.
S_PROP_Fence-Elec	The center of all Electric Fences. The fence must be digitized at ground elevation.
S_PROP_Fence-farm field	The center of all Farm Field Fences. The fence must be digitized at ground elevation.
S_PROP_Fence-iron	The center of all Iron Fences. The fence must be digitized at ground elevation.
S_PROP_Fence-metal	The center of all Metal Fences. The fence must be digitized at ground elevation.
S_PROP_Fence-other	The center of all Other type of Fences. The fence must be digitized at ground elevation.
S_PROP_Fence-privacy	The center of all Privacy Fences. The fence must be digitized at ground elevation.
S_PROP_Fence-stone	The center of all Stone Fences. The fence must be digitized at ground elevation.
S_PROP_Fence-wood	The center of all Wood Fences. The fence must be digitized at ground elevation.
S_PROP_Fence-woven rail	The center of all Woven Rail Fences. The fence must be digitized at ground elevation.
S_PROP_Garden	The outline of all residential Gardens at ground elevation.
S_PROP_Gas fill cap	All Gas Fill Caps. This cell must be digitized in the center of the cap.
S_PROP_Gas pump	The outline of all individual Gas Pumps at the elevation of the island or ground.
S_PROP_Gas pump island	The top leading edge of the island containing Gas Pumps. Also digitize a Level Sting at the bottom of the island.
S_PROP_Gate	Center of all Gates. The gate must be digitized from the center of the Gate Post to the end of the gate.
S_PROP_Gate post	All Gate Posts. This cell must be digitized in the center of the post at ground elevation.
S_PROP_GC Cart Path	The edge of all Golf Course Cart Paths. If needed also digitize a Level Sting at the bottom of the car path at the ground elevation.

S_PROP_GC Fairway	The edge of all Golf Course Fairways at ground elevation.
S_PROP_GC Green	The edge of all Golf Course Greens at ground elevation.
S_PROP_GC Sand Trap	The top leading edge of all Golf Course Sand Traps. If needed digitize a Level Sting at the bottom of the leading edge of the sand trap at ground elevation.
S_PROP_GC Tee Box	The edge of all Golf Course Tee Boxes at ground elevation. If the tee box is elevated digitize Level Stings where needed.
S_PROP_Grave approx location	The approximate location of all Single Grave locations.
S_PROP_Landscaping	The outline of all Commercial or Residential Landscaping.
S_PROP_Leachfield	The outline of all Leach Fields. Leach Fields must be digitized at ground elevation.
S_PROP_Line-field division	The outline of all Farm Fields at ground elevation.
S_PROP_Mail box (double box)	All Double Mail Boxes. This cell must be digitized in the center of the Mail Box Post at ground elevation.
S_PROP_Mail box (mult. boxes)	All Multiple Mail Boxes. This cell must be digitized in the center of the Mail Box Post at ground elevation.
S_PROP_Mail box (single box)	All Single Mail Boxes. This cell must be digitized in the center of the Mail Box Post at ground elevation.
S_PROP_Mail box (USPS-FedEx)	All United States Postal Service, FedEx or UPS Mail Boxes ect. This cell must be digitized in the center of the box at ground elevation.
S_PROP_Orchard	The outside edge of all Orchards at ground elevation.
S_PROP_Outline of Porch or Deck	The outside edge of Porches or Decks.
S_PROP_Pole-flag	All Residential or Commercial Flag Poles. This cell must be digitized at the center of the pole at ground elevation.
S_PROP_Post	All Posts. This cell must be digitized in the center of the post at ground elevation.
S_PROP_Private lamp post	All Private Lamp Posts. This cell must be digitized in the center of the lamp post at ground elevation.
S_PROP_Property owner	All Property Owners. This cell must be digitized at ground elevation and noted with the Property Owners Name and/or other pertinent information.
S_PROP_Satellite dish	All Satellite Dishes. This cell must be digitized in the center of the Satellite Dish.
S_PROP_Septic tank	All Septic Tanks. This cell must be digitized in the center of the tank opening.
S_PROP_Sidewalk	The top leading edge of all Sidewalks. If the sidewalk is elevated place additional Level Sting at the ground elevation.
S_PROP_Sign post-commercial	All Commercial Signs. This cell must be digitized in the center of the post.
S_PROP_Sign-commercial	The outline of all Commercial Signs. All Commercial signs must be digitized at ground elevation or at elevation of pedestal.
S_PROP_Sign-dbl post	All Double Post Signs. This cell must be digitize between the double posts and rotated to correct angle.
S_PROP_Sign-railroad	All Railroad Signs. This cell must be digitized in the center of the post.
S_PROP_Sign-single post	All Single Post Signs. This cell must be digitized in the center of the post.
S_PROP_Sprinkler head	All Sprinklers. This cell must be digitized in the center of the sprinkler head.
S_PROP_Steps	The outline of all Steps.
S_PROP_Storage tanks	The outline of all Storage Tanks.
S_PROP_Swimming pool	The outline of all Swimming Pools.
S_PROP_T-post (Fence Post)	All Fence T-Posts. This cell must be digitized in the center of the post
S_PROP_Turn apron	The edge of all Turn Aprons.
S_PROP_Well	All Wells. This cell must be digitized in the center of the well opening.
S_PROP_Well Pit	All Well Pits. This cell must be digitized in the center of the well pit.

S_RDWY_Asphalt-approach	The edge of any Asphalt Approach. If elevated place additional Level String at the ground elevation.
S_RDWY_Asphalt-island	The top leading edge of all Asphalt Islands. Also place an additional Level String at the ground elevation.
S_RDWY_Asphalt-slab	The edge of all Asphalt Slabs. If elevated place an additional Level String at the ground elevation.
S_RDWY_Controller Cab-traffic	All Traffic Control Cabinets. This cell must be digitized in the center and at elevation of ground or concrete slab.
S_RDWY_Curb-back	The back edge of all Curbs.
S_RDWY_Curb-bottom	The bottom of all Curbs if there is no apparent Gutter Flow Line.
S_RDWY_Curb-rolled	The center of all Rolled Curbs.
S_RDWY_Curb-top	The top leading edge of any Curb. Also place an additional Gutter Flow Line or Level String at ground elevation.
S_RDWY_Drive-commercial	The edge of all Commercial Drives, also digitize the correct material symbology to defi material. If elevated place an additional Level String at the ground elevation.
S_RDWY_Drive-field	The all Field Drives, also digitize the correct material symbology to define the type of drive material. If elevated place an additional Level String at the ground elevation.
S_RDWY_Drive-private	The edge of all Private Drives, also digitize the correct material symbology to define the type of drive material. If elevated place an additional Level String at the ground elevation.
S_RDWY_Edge of gravel	The edge of any Gravel that is not related to a Road or Drive, also digitize the correct material symbology to define the type of drive material. If elevated place an additional Level String at the ground elevation.
S_RDWY_Guardrail-aluminum	The top of Aluminum Guard Rail where it meets the blockouts or post.
S_RDWY_Guardrail-beam	The top of Beam Guard Rail where it meets the blockouts or post.
S_RDWY_Guardrail-cable	The top of Cable Guard Rail where it meets the blockouts or post.
S_RDWY_Guardrail-other	The top of Other Type Guard Rail where it meets the blockouts or post.
S_RDWY_Guardrail-wooden	The top of Wooden Guard Rail where it meets the blockouts or post.
S_RDWY_Mail box approach	The edge of all Mailbox Approaches, also digitize the correct material symbology to define the type of approach material. If elevated place an additional Level String at the ground elevation.
S_RDWY_Median cross over	The edge of all Median Crossovers, also digitize the correct material symbology to define the type of approach material. If elevated place an additional Level String at the ground elevation.
S_RDWY_Pavement-edge	The edge of Pavement for all Public Roads. If elevated place an additional Level String at the ground elevation.
S_RDWY_Road crown	The Road Crown of all roads. This may or may not be the center line of the road.
S_RDWY_Shoulder-edge	The edge of Shoulder for all Public Roads. If elevated place an additional Level String at the ground elevation.
S_RDWY_Underdrain	All Underdrain features.
S_RW_Line-cemetery	The outside edge of all Cemeteries. If elevated place an additional Level String at the ground elevation.
S_RW_Line-county	All County Lines.
S_RW_Line-Natl Forest	All National Forest Lines.
S_RW_Line-property	All Property Lines.
S_RW_Line-Right of Way	All Right of Way Lines.
S_RW_Line-state	The Indiana State line.

S_RW_Line-town-city	All Town Lines.
S_RW_R-W marker Conc	All Concrete Right of Way Markers. This cell must be digitized on the backside center of the monument.
S_RW_R-W marker granite	All Granite Right of Way Markers. This cell must be digitized on the backside center of the monument.
S_RW_R-W marker stone	All Stone Right of Way Markers. This cell must be digitized on the backside center of the monument.
S_RW_Town line marker	All Town Line Markers. This cell must be digitized in the center of the marker.
S_SURF_Aerial Boundary	All Aerial Mapping Model Boundaries. This boundary must represent the neat models lines and must remain inside the usable stereo coverage areas. Also, these boundaries must be snapped to adjacent boundaries.
S_SURF_boundary string	All Interior and Exterior Boundary Strings. These boundary strings must be snapped to all vertically sensitive data at the edge of the Aerial Mapping coverage.
S_SURF_Level string	The sharp changes in the ground Topography.
S_SURF_Toe of slope	All Toes of Slope at ground elevation.
S_SURF_Top of bank	All Tops of Bank at ground elevation.
S_TOPO_Aerial Obscured	All Aerial Obscured areas. Add text to describe what the ground is obscured by.
S_TOPO_Brick-Block Wall	The top leading edge of all Brick or Block Walls. Also place a Level String at ground elevation outlining the Brick or Block Wall.
S_TOPO_Conc elevation	An elevation reading for all Concrete slabs,porches and steps.
S_TOPO_Controller Cab-RR	All Railroad Control Cabinets. This cell must be digitized in the center of the cabinet and at elevation of ground or concrete slab.
S_TOPO_Edge of Conc	The edge all Concrete. If elevated place an additional Level String at the ground elevation.
S_TOPO_Edge of Conc slab	The edge of all Concrete Slabs. If elevated place an additional Level String at the ground elevation.
S_TOPO_Finished floor	All Finished Floor Elevations. This cell must be digitized just inside the threshold of doorway for Commercial or Residential property. Typically used for Flood Zone Exemptions.
S_TOPO_Matl Prop-Asphalt	All Asphalt Material.
S_TOPO_Matl Prop-Boulder	All Boulder material. This cell must be digitize in the center top of the boulder or center top of a pile or mound of boulders.
S_TOPO_Matl Prop-Brush	All Weeds material.
S_TOPO_Matl Prop-Conc	All Concrete material.
S_TOPO_Matl Prop-Crushed Stone	All Crushed Stone material.
S_TOPO_Matl Prop-Dirt	All Dirt material. This cell must be digitized at ground elevation or at the top of any pile or mound.
S_TOPO_Matl property	All Materials not listed.
S_TOPO_Matl Prop-Grass	All Grass material.
S_TOPO_Matl Prop-Gravel	All Gravel material. This cell must be digitized at ground elevation or at the top of any pile or mound.
S_TOPO_Matl Prop-Mulch	All Mulch material. This cell must be digitized at ground elevation or at the top of any pile or mound.
S_TOPO_Matl Prop-Pond	All Ponds. This cell must be digitized in the center of the pond at the elevation of the water surface.
S_TOPO_Matl Prop-Stone	All Stone material. This cell must be digitized at ground elevation or at the top of any pile or mound.
S_TOPO_Matl Prop-Weeds	All Brush material.

S_TOPO_Matl Prop-Woods	All Woods material.
S_TOPO_New feature	The center of all Unknown Objects.
S_TOPO_Nursery	The outline of all Commercial or Residential Nursery's.
S_TOPO_Point-new topo string	The outline of all Unknown Objects.
S_TOPO_Railroad	The top inside gauge of all Railroad tracks.
S_TOPO_Riprap	The edge of all Rip-Rap.
S_TOPO_Rock outcrop	The edge of all Rock Outcrop.
S_TOPO_Row of trees-coniferous	The beginning and the end of a Row of Coniferous Trees.
S_TOPO_Row of trees-deciduous	The beginning and the end of a Row of Deciduous Trees.
S_TOPO_Spot elevation	All Spot Elevations. The cell for Spot Elevations must be digitized at ground elevation.
S_TOPO_Stone wall	The top leading edge of all Stone Walls. Also place a Level String at ground elevation outlining the Stone Wall.
S_TOPO_Stump	All Stumps. This cell must be digitized in the center of the stump.
S_TOPO_Text	Any annotation need to describe Unknown items or Obscured areas.
S_TOPO_Tree coniferous	All Coniferous Trees. This cell must be digitized in the center of the tree.
S_TOPO_Tree deciduous	All Deciduous Trees. This cell must be digitized in the center of the.
S_TOPO_Woods-brush line	The edge of all Woods or Brush areas.
S_TRAF_Arrow left turn only	All painted Left Turn Arrow markers on the roadways.
S_TRAF_Arrow left-straight	All painted Left Turn/Straight Arrow markers on the roadways
S_TRAF_Arrow right turn only	All painted Right Turn Arrow markers on the roadways.
S_TRAF_Arrow right-straight	All painted Right Turn/Straight Arrow markers on the roadways.
S_TRAF_Arrow straight only	All painted Straight Arrow markers on the roadways.
S_TRAF_Box Truss Cell	The post for all Box Truss Signs. This cell must be digitized in the center of the post.
S_TRAF_Cable Span Cell	The post for all Cable Span Signs. This cell must be digitized in the center of the post.
S_TRAF_Delineator Post	All Delineator Post. This cell must be digitized in the center of the post.
S_TRAF_Double Arm Cant Cell	The post for all Double Arm Cantilever Signs. This cell must be digitized in the center of the post.
S_TRAF_Handhole	All Hand Holes. This cell must be digitized in the center of the Hand.
S_TRAF_Lane Lines	All Lane Line Markings Solid or Dashed.
S_TRAF_Magnetic detector sleeve	All Magnetic Detector Sleeves.
S_TRAF_MonotubeCell	The post for Monotube Signs. This cell must be digitized in the center of the post.
S_TRAF_Painted Crossing	All painted X-ING markers on the roadways.
S_TRAF_Painted ONLY	All painted ONLY markers on the roadways.
S_TRAF_Painted RR Xing	All painted Railroad crossing markers on the roadways.
S_TRAF_Painted School Xing	All painted SCHOOL crossing markers on the roadways.
S_TRAF_Pullbox	All Pull Boxes. This cell must be digitized in the center of the pole.
S_TRAF_Railroad Sig	All Railroad Signals. This cell must be digitized in the center on the signal.
S_TRAF_Sig conduit	The location of all Signal Conduits.
S_TRAF_Sig loop detector	The center of all Signal Loop Detector cables.
S_TRAF_Sig loop detector box	All Traffic Signal Loop Detector Boxes. This cell must be digitized in the center of the box.
S_TRAF_Sig-no mast arm	All Traffic Signals that do not contain a mast arm. This cell must be digitize in the center of the signal.
S_TRAF_Sign-Oh box truss	The top edge of all Box Truss Signs.
S_TRAF_Sign-Oh cable span	The top edge of all Cable Span Signs.

S_TRAF_Sign-Oh double arm cant	The top edge of all Double Arm Cantilever Signs.
S_TRAF_Sign-Oh monotube	The top edge of all Monotube Signs.
S_TRAF_Sign-Oh single arm cant	The top edge of all Single Arm Cantilever Signs.
S_TRAF_Sign-Oh tri cord	The top edge of all Tricord Signs.
S_TRAF_Single Arm Cant Cell	The post for all Single Arm Cantilever Signs. This cell must be digitized in the center of the post.
S_TRAF_Stop bar	All painted Stop bars in the roadways.
S_TRAF_Street light conduit	The location of all Street Light Conduit.
S_TRAF_Tricord Cell	The post for all Tricord Signs. This cell must be digitized in the center of the.
S_UTIL_Air Conditioning Unit	All Air Conditioning Units for Commercial or Residential property. This cell must be digitized in the center of the unit.
S_UTIL_Anchor for guy rope	All Guy Cable Anchors. This cell must be digitized in the center of the anchor where it enters the ground.
S_UTIL_Controller Cab-Elec	All Electric Control Cabinets. This cell must be digitized in the center of the cabinet
S_UTIL_Controller Cab-Tel	All Telephone Control Cabinets. This cell must be digitized in the center of the cabinet.
S_UTIL_Elec transformer box	The outline of the Transformer Box.
S_UTIL_Fiber optic marker	All Fiber Optic Markers. This cell must be digitized in the center of the cabinet.
S_UTIL_Fire hydrant	All Fire Hydrants. This cell must be digitized in the center top of the Fire Hydrant.
S_UTIL_Gas shutoff	All Gas Shut Off Valves. This cell must be digitized in the center of the valve.
S_UTIL_Gas Station Mon Well	All Gas Monitoring Wells. This cell must be digitized in the center of the cover.
S_UTIL_Gas vent pipe	All Gas Vent Pipes. This cell must be digitize in the center of the pipe(s).
S_UTIL_Ground light	All Residential or Commercial Ground Lights. This cell must be digitized in the center of the light.
S_UTIL_Hedge	The outline of all Hedges. Hedges must be digitized at ground elevation.
S_UTIL_High pressure tap	All High Pressure Taps. This cell must be digitized in the center of the tap
S_UTIL_Manhole-cable TV	All Cable TV Manholes. This cell must be digitized in the center of the manhole.
S_UTIL_Manhole-drainage	All Drainage Manholes. This cell must be digitized in the center of the manhole.
S_UTIL_Manhole-Elec	All Electric Manholes. This cell must be digitized in the center of the manhole.
S_UTIL_Manhole-gas	All Gas Manholes. This cell must be digitized in the center of the manhole.
S_UTIL_Manhole-GasStation	All Gas Station Manholes. This cell must be digitized in the center of the manhole.
S_UTIL_Manhole-other	All Other Types off Manholes. This cell must be digitized in the center of the manhole.
S_UTIL_Manhole-sewer	All Sewer Manholes. This cell must be digitized in the center of the manhole.
S_UTIL_Manhole-Tel	All Telephone Manholes. This cell must be digitized in the center of the manhole.
S_UTIL_Manhole-traffic Sig	All Traffic Signal Manholes. This cell must be digitized in the center of the manhole.
S_UTIL_Manhole-water	All Water Manholes. This cell must be digitized in the center of the manhole.
S_UTIL_Metal tower	All Metal Towers. This cell must be digitized in the center of the tower at ground elevation and rotated, then scaled.
S_UTIL_Meter-Elec	All Electric Meters. This cell must be digitized in the center of the meter.
S_UTIL_Meter-gas	All Gas Meters. This cell must be digitized in the center of the Gas Meter.
S_UTIL_Meter-water	All Water Meters. This cell must be digitized in the center of the meter.
S_UTIL_Natural gas storage well	All Natural Gas Storage Wells. This cell must be digitized in the center of

	the well opening.
	all Natural Gas Wells. This cell must be digitized in the center of the well opening.
S_UTIL_NaturalGasShutOff	All Natural Gas Shut off Valves. This cell must be digitized in the center of the valve.
S_UTIL_Pedistal-cable	All Cable Pedestals. This cell must be digitized in the center of the pedestal.
S_UTIL_Pedistal-Elec	All Electric Pedestals. This cell must be digitized in the center of the pedestal.
S_UTIL_Pedistal-gas	All Gas Pedestals. This cell must be digitized in the center of the pedestal.
S_UTIL_Pedistal-Tel	All Telephone Pedestals. This cell must be digitized in the center of the pedestal.
S_UTIL_Petroleum HPV	All Petroleum Gas Shut Off Valves. This cell must be digitized in the center of the valve.
S_UTIL_Petroleum vent pipe	All Petroleum Vent Pipes. This cell must be digitized in the center of the vent pipe.
S_UTIL_Pole	All Poles. This cell must be digitize in the center of the pole.
S_UTIL_Pole-guy or stub	All Guy Wire Poles or Stubs. This cell must be digitized in the center of the pole.
S_UTIL_Pole-joint power-Tel	All Joint Power and Telephone Poles. This cell must be digitized in the center of the pole.
S_UTIL_Pole-light	All Light Poles. This cell must be digitized in the center of the pole.
S_UTIL_Pole-light on joint	All Lights on Joint Poles. This cell must be digitized in the center of the pole.
S_UTIL_Pole-light on power	All Lights on Power Poles. This cell must be digitized in the center of the pole.
S_UTIL_Pole-mast arm	All Mast Arm Poles. This cell must be digitized in the center of the pole.
S_UTIL_Pole-power	All Power Poles. This cell must be digitized in the center of the power pole.
S_UTIL_Pole-Tel	All Telephone Poles. This cell must be digitized in the center of the pole.
S_UTIL_Pole-telegraph	All Telegraph Poles This cell must be digitized in the center of the pole
S_UTIL_Pole-traffic Sig-strain	All Traffic Signal Strain Poles This cell must be digitized in the center of the pole
S_UTIL_Prop-Elecal Box	All Electric Boxes This cell must be digitized in the center of the box
S_UTIL_Riser-Elec	All Electric Risers and for Electric Lines that run up poles This cell must be digitized in the center of the riser.
S_UTIL_Riser-Tel	All Telephone Risers and for Telephone Lines that run up poles This cell must be digitized in the center of the riser.
S_UTIL_Riser-television	All Cable TV Risers and for Cable TV Lines that run up poles This cell must be digitized in the center of the riser.
S_UTIL_Riser-water	All Water Risers This cell must be digitized in the center of the riser.
S_UTIL_Tel booth	All Telephone Booths This cell must be digitized in the center of the booth
S_UTIL_Tel-press canister	All Canisters This cell must be digitized in the center of the post that the canister is attached to.
S_UTIL_Tel-splice tub	All Telephone Splice Tubs This cell must be digitized in the center of the tub.
S_UTIL_Ug Gas Vault	All Underground Gas Vault features.
S_UTIL_Ug-cable TV	All Underground Cable TV features.
S_UTIL_Ug-Elec	All Underground Electric features.
S_UTIL_Ug-gas	All Underground Gas features.
S_UTIL_Ug-high pressure gas	All Underground High Pressure Line features.
S_UTIL_Ug-other	All Other or Unknown Underground features.
S_UTIL_Ug-petroleum	All Underground Petroleum features.
S_UTIL_Ug-sanitary sewer	All Underground Sanitary Sewer features.
S_UTIL_Ug-storm san sewer	All Underground Rain or Storm Water Sewer features.

S_UTIL_Ug-Tel	All Underground Telephone features.	
S_UTIL_Ug-water	All Underground Water features.	
S_UTIL_Valve box	All Residential and Commercial Irrigation Valves Boxes This cell must be digitized in the center of the valve box.	
S_UTIL_Water gate	All Water Gates This cell must be digitized in the center top of the gate.	
S_UTIL_Water shutoff	All Water Shutoff Valves This cell must be digitized in the center of the valve.	